5572

RECORD COPY

OTS: 60-41,383

JPRS: 5572

20 September 1960

A CHANGE IN THE VECTORELECTROCARDIOGRAM IN HYPERTROPHY OF THE LEFT VENTRICLE

By E. A. Kyandzhuntseva
and
V. I. Makolkin

- USSR -

Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.

~~Price: $0.50~~

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
205 EAST 42nd STREET, SUITE 300
NEW YORK 17, N. Y.

JPRS: 5572
CSO: 4595-N

A CHANGE IN THE VECTORELECTROCARDIOGRAM IN HYPERTROPHY OF THE LEFT VENTRICLE

[Following is the translation of an article by E.A.Kyandzhuntseva and V.I.Makolkin entitled "Izmeneniye Vektorkardiogrammy pri Gipertrofii Levogo Zheludochka" (English version above) in Klinicheskaya Meditsina (Clinical Medicine), Vol.XLI, No. 6, Moscow, 1960, pages 45-50.]

The Faculty Therapeutic Clinic (Director - active member of the Academy of Medical Sciences USSR Prof. V.N.Vinogradova) of the First Moscow Order of Lenin Medical Institute imeni I.M.Sechenov

In the present report we are presenting an analysis of the vectorcardiograms of patients with typical signs of left ventricular hypertrophy in various stages.

Altogether we analyzed 140 vectorcardiograms, of which 70 were of patients with hypertension in stages I, II, and III, 20 were of patients with chronic nephritis. 40 were of patients with aortic valvular disease, and ten were of patients with mitral valvular insufficiency. The vectorcardiograms were recorded by the system of precordial leads recommended by I.T.Akulinichev, and in a number of cases, for control and comparison, were also recorded by the cube system (Grishman and Scherlis, 1952).

For recording purposes, we used the VEKS-01 apparatus, with a sensitivity of one mv = two cm.

In addition to vectorcardiograms, in all patients we took electrocardiograms using standard and unipolar leads from the extremities and the chest. In analysis of the vectorcardiograms, we continually compared the data with those of roentgenologic and clinical investigations. Basic attention in this was given to the changes in the QRS loop of the vectorcardiogram. Insofar as it was possible with the available degree of amplification of the apparatus, we also analysed the end components of the vectorcardiogram - the T loop and the S-T junction.

In evaluating the spatial position of the QRS loop, it should first be noticed that, in left ventricular hypertrophy, there is a tendency toward displacement around the sagittal axis in a counter-clockwise direction, i.e. from left to right. The most sensitive in this respect is projection I. In the normal the principal axis of the loop in this projection is found in the sector from +80 to +35 degrees; in left ventricular hypertrophy the sector is displaced to the left, occupying a position from +60 to -10 degrees. However, in the eary stages of hypertrophy, this change is

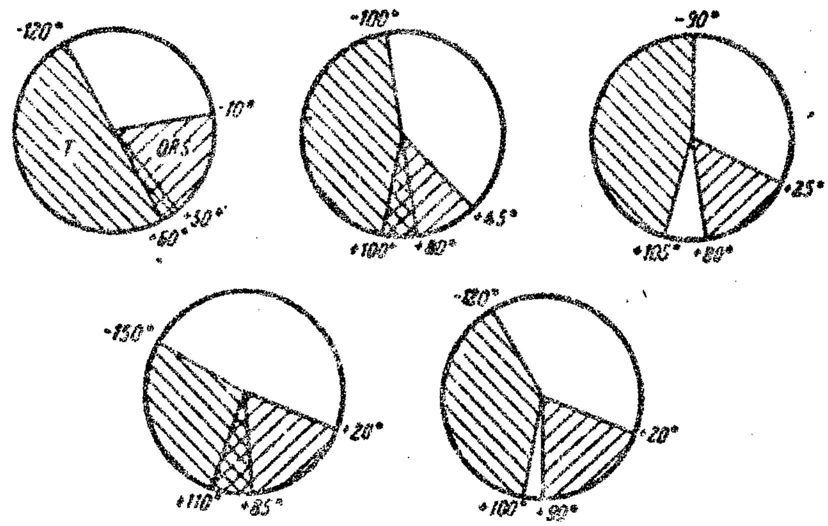

Fig. 1. Placement of the principal axis of the QRS and T loops in hypertrophy of the left ventricle in the system of projections of I. T. Akulinichev.

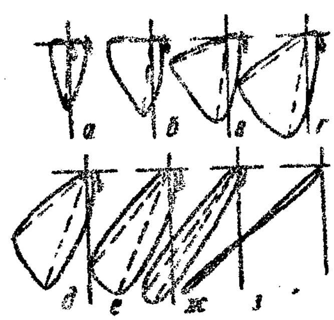

Fig. 2. Scheme of changes in the QRS loop in left ventricular hypertrophy (in projection III, according to the method of I. T. Akulinichev).

commonly absent; in this there is not infrequently a normal or even vertical position of the principal QRS axis. In projection II of the vectorcardiogram, the principal axis of the QRS loop is ordinarily situated in the sector from +100 to +45 degrees, in projection III from +80 to +25 degrees, in projection IV from +100 to +20 degrees, and in projection V from +90 to +20 degrees (Fig.1).

The second typical change with respect to the spatial situation of the QRS loop is a tendency to a slight shift about its long axis in a counterclockwise direction (when viewed from the apex of the loop). This shift consists in the fact that, ordinarily, the diameter of the QRS loop is greatest in projections III and I and least in projection II. In this, the plane of the QRS loop becomes, as it were, parallel to the plane of lead III of the vectorcardiogram (along the X axis). As a result of this shift, ~~there is~~ in projection I the loop rotates counterclockwise; since this shift is slight, in no projection of the vectorcardiogram is the direction of rotation of the loop so greatly altered as to exceed the limits of normal. In projection II, just as in the normal, the rotation of the QRS loop is counterclockwise, but is clockwise in projection III. Although this shift of the QRS loop was quite typical for left ventricular hypertrophy, nonetheless in some cases, in projection I, the loop of the vectorcardiogram was long, narrow, and crossed; this indicates that its plane is perpendicular to the plane of projection I of the vectorcardiogram. In this, in projections IV and

V, there is also crossing. These variants were commonly combined with the most vertical position of the loop (from +50 to +70 degrees) in projection I and, evidently, were associated with the original vertical position of the heart.

Another change characteristic of left ventricular hypertrophy was an increase in the area of the QRS loop. If with the degree of amplification of the apparatus which we used (mentioned above), this does not exceed seven to eight sq. cm., then in hypertrophy of the left ventricle the area of the QRS loop is increased considerably, reaching, in some instances, 70 to 80 sq. cm. The increase in the area of the QRS loop to such dimensions apparently proceeds parallel to the development of hypertrophy. Only in early forms of hypertrophy, and also with marked cardiosclerosis, is the area of the QRS loop not significiantly different from that of the normal loop.

The most characteristic and constant change in left ventricular hypertrophy, from our point of view, was the change in the form of the QRS loop, associated with a predominiance of forces or of vectors directed posteriorly and to the left. In this it is essential to note that this predominance of posterior and left forces may occur at different times during the QRS period, depending apparently on the stage of hypertrophy, and this in turn determines the nature of the changes in the form of the QRS loop.

We were successful in observing the dynamics of changes in the form of the QRS loop with progress of hypertrophy. This is

shown in the scheme (Fig.2), which represents the QRS loop in projection III, where these changes are most noticeable.

Fig.2 - Scheme of changes in the QRS loop in left ventricular hypertrophy (in projection III, according to the method of I.T.Akulinichev)

Early changes in the vectorcardiogram in left ventricular hypertrophy ordinarily consisted in the appearance of an additional pole at the end of the QRS loop which not infrequently predominated over the basic pole (Fig.2, b and c) and was directed toward the fifth electrode. As a result of this, the QRS loop became rounded and widened; a considerable part of it was traced in the left lower quadrant of projection III. With progression of hypertrophy, the appearance of the additional pole was observed to occur earlier and earlier. Externally this was expressed in a gradual approximation of the additional pole to the basic one, which in turn led to the production of a long and narrow loop inclined posteriorly and to the left, as well as slightly upward, as compared with the normal (Fig.2, d,e,f and g). The limit of this change was the formation of long loops, forquently with crossing (in nearly all projections), which is typical of left bundle branch block (Fig.2,h). This dynamics of the changes in the QRS loop is unconditionally schematic.

The predominance of left and posterior forces was not always expressed in the formation of a pronounced additional pole, but

in these cases the QRS loop was nearly round, and most of it was located in the left lower quadrant of projection III. Parallel with this change in the form of the QRS loop, there was an increase in its area. The largest area of the QRS loop was noted in stages c,d, and e (see Fig.2). The area of long, narrow loops was ordinarily not so large, whereas the axis of the loop surpassed the normal by two to two and a half times. In cases of long-standing change, there was a reduction in the length of the loop, but the form remained narrow, slightly elongated, and not infrequently crossed.

The gradual approximation of the additional and the basic poles of the QRS loops and the formation of long, narrow loops (Fig.2, e,f,g, and h) were associated, as a rule, with a constant disturbance of intraventricular conduction.

Together with changes in the QRS loop there were changes in the T loop and the S-T junction. The T loop showed a tendency to changes in orientation in a direction opposite to that of the QRS loop, and situated in projection I in the sector from +50 to -150 degrees, in projection II in the sector from +80 to -100 degrees, in projection III in the sector from +105 to -90 degrees, in projection IV in the sector from +85 to -150 degrees, and in projection V in the sector from +100 to-120 degrees.

In addition to the orientation of the T loop, there were changes in the form of it: from strictly oval it converted to round, with irregular orientations, or became elongated. Commonly

the T loop was increased, but not infrequently there was a diminution in it. Together with changes in the T loop, there was more or less failure of the QRS loop to close prior to tracing the T loop.

These changes in the T loop were unquestionably intensified with progression of hypertrophy and of the changes in the myocardium associated with it, but we could discern no strict connection with the above-mentioned dynamics of changes in the QRS loop. Elongation of the QRS loop, as a rule, was accompanied by changes in the S-T junction and the T loop, but as to the rounded forms of the QRS loops, in this we observed either a completely unchanged T loop or marked changes in both the T loop and the S-T junction.

Such were the general characteristics of changes which we were able to detect in cases of left ventricular hypertrophy.

In analyzing our findings, we conditionally divided all of our patients into three groups, depending upon the degree of progression in them of the condition of left ventricular hypertrophy.

The first group contained patients with early or moderate development of hypertrophy. This included patients with hypertrophy in stage I, chronic nephritis (hypertensive form) with disease of less than two years' duration, mitral valvular disease with predominance of insufficiency but still compensated, and the initial stages of aortic valvular disease.

As an illustration, let us consider a case.

Patient S., 25 years old, entered the clinic December 23,

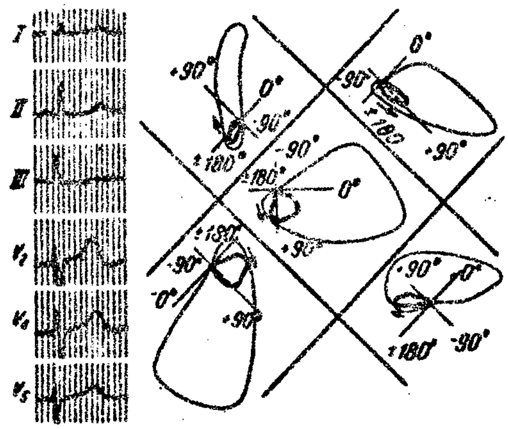

Fig.3 - Vectorcardiogram and ECG of patient S.

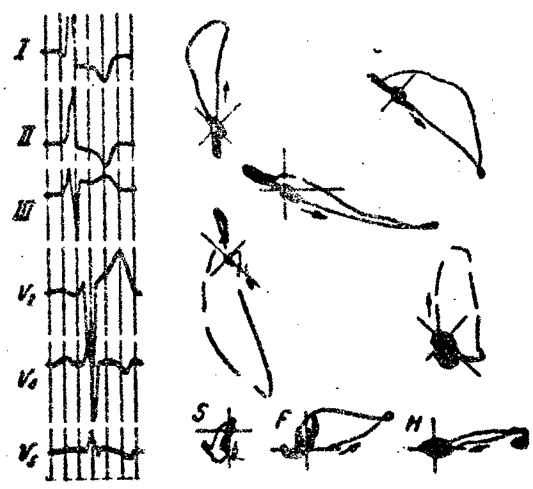

Fig.4 - Vectorcardiogram and ECG of patient K.

1957 with a diagnosis of chronic nephritis. In 1948 he had suffered acute nephritis. Since August 1957, he had noticed increase in blood pressure to 160/100 mm Hg; since December 1957 the arterial pressure had increased to 190/120 mm Hg. The left border of the heart was in the mid-clavicular line; the heart tones were clear, and A2 was greater than P2. The arterial pressure varied from 160/100 to 210/140 mm Hg. X-ray studies showed a moderate increase in heart size, predominantly of the left ventricle.

ECG (Fig.3) showed normal position of the electrical axis of theheart, with deep S waves in the chest leads. On the vectorcardiogram theprincipal axis of the QRS loop was displaced to the left and posteriorly. Rotation of the QRS loop in the first projection was counterclockwise. There was an increase in the are of the QRS loop to 15.3 sq.cm. The was clearly visible terminal deviation of the QRS loop in projections I, III, and IV to the left and posteriorly. The QRS loop changed in type, as shown in Fig.2,d. The orientation of the T loop changed very little, butin projections I and III the T loop was slightly increased and deformed (see Fig.3).

In this case the vectorcardiogram permitted positive diagnosis of left ventricular hypertrophy, whereas there were no changes on the electrocardiogram.

The second group comprised patients with advanced hypertrophy, in which the ventricular dilatation was moderate (hypertension stage II, chronic nephritis with disease of more than one to two years' duration, aortic valvular disease with pronounced clinical manifestations).

Patient K., 33 years old, entered the clinic on 14 October 1958 with a diagnosis of aortic valvular disease with predominance of stenosis of the aortic valve. In 1943, the heart lesion had been detected on routine examination. Since 1952 the patient had suffered dyspnea and pain in the heart region on walking.

The left border of the heart was two cm beyond the mid-clavicular line. There were loud systolic and faint diastolic murmurs in the aortic region. The arterial pressure was 95/75 mm Hg. X-ray showed enlargement of the heart to the left; the retrocardial distance in the second oblique position was reduced by the shadow of the considerably enlarged left ventricle; the aorta was widened and irregular, especially in the ascending portion of the aortic arch.

ECG (Fig.4) showed deviation of the electrical axis of the heart to the left, inverted T waves in standard leads I and II and in the left chest leads and depression of the S-T segment in

leads I, II, and V_5. On the vectorcardiogram the principal axis of the QRS loop was considerably displaced to the left and posteriorly. There was an increase in the QRS area to 16 sq.cm. The form of the QRS loop was modified in accordance with the type shown in Fig.2,f. The QRS loop was not closed. The T loop was sharply deviated to the right and upward in a direction opposite to that of the QRS loop, which was to the left and backward as recorded by the cube system. The QRS loop was not closed and was in a direction opposite to that of the T loop (see Fig.4).

The third group comprised patients in whom hypertrophy of the left ventricle was complicated by marked dilatation and by conjoint cardiosclerotic changes with disturbance of conduction pathways (aortic valvular disease and hypertension stage III).

Patient L., 43 years old, entered the clinic on April 8, 1959 with the diagnosis of subacute bacterial endocarditis and aortic insufficiency starting in October of 1958.

The left border of the heart was two cm beyond the mid-clavicular line. At Botkin's point and over the aorta, systolic and diastolic murmurs could be heard. The blood pressure was 130/45 mm Hg. X-ray of the chest showed enlargement of the heart (left ventricle).

The ECG (Fig.5) showed deviation of the electrical axis of the heart to the left; the QRS interval was 0.13 second; the T wave in standard lead I and in the left chest leads was inverted. The S-T segment was depressed in the same leads. Conclusion: left

bundle branch block. On the vectorcardiogram the principal axis of the QRS loop was sharply displaced to the left and backward. There was an increase in the QRS area to 12.3 sq.cm. The QRS loop was changed as shown in Fig.2,g, was not closed, and was directed opposite to the direction of the T loop. The T loop was oriented to the right and anteriorly. On the vectorcardiogram recorded by the cube system there was deviation of the QRS loop to the left, posteriorly, and upward. Rotation of the QRS loop in the horizontal plane was counter-clockwise (in left bundle branch block the rotation of the QRS loop is ordinarily clockwise).

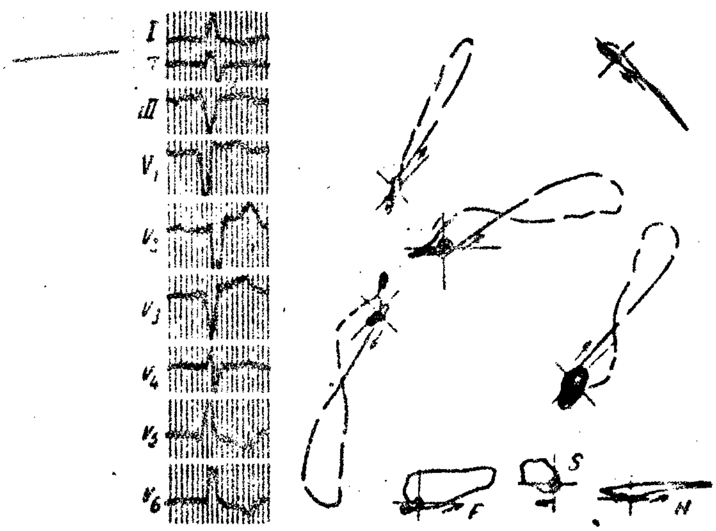

Fig.5 - Vectorcardiogram and ECG of patient L.

In this case the vectorcardiogram, recorded by the Akulinichev system, showed a transition from the picture of left ventricular hypertrophy to that of left bundle branch block.

Our findings on the changes of the vectorcardiogram in left ventricular hypertrophy are in fundamental agreement with the findings of a number of Soviet and foreign authors (Z.Z.Dorofey-

eva and I.F.Ignat'yeva, 1958; N.I.Kechker,1958; M.B.Tartakovskiy and E.A.Solov'yeva, 1958; Grishman and Scherlis, 1952; Moran, Burch, and Abildskov, 1954; Lamb, Grosgurin, and Duchosal, 1956; Pantridge and associates, 1950; Wenger, 1956).

This study has convinced us of the fact that vectorcardiography is an excellent supplement to the usual ECG studies in the diagnosis of left ventricular hypertrophy, and, in cases of the early forms of hypertrophy, has a decided advantage over the ECG.

Conclusions

(1) Analysis was made of 140 vectorcardiograms of patients with left ventricular hypertrophy.

(2) Vectorcardiograms in left ventricular hypertrophy show characteristic changes expressed in the form of an increase in the QRS area, and changes in the spatial position and form of the QRS and T loops.

(3) Vectorcardiography is an excellent supplementary method to the usual ECG studies for specifying the degree of hypertrophy and, in cases of the early diagnosis of left ventricular hypertrophy, has definite advantages over the ECG.

Bibliography

Akulinichev, I.T., "Klin. Med." [Clinical Medicine], 1950, No.10, 64, and 1951, No.8, 44

Akulinichev, I.T., "Voyen.-Med. Zhurn." [Military Medical Journal], 1956, No.1, 79

Dorofeyeva, Z.Z., Ignat'yeva, I.F., "Ter. Arkh." [Therapeutic

Archives], 1958, No.3, 55

Kechker, M.I., "Thesesof reports of the First All-Russion Conference of Therapeutists", Moscow, 1958, 156

Tartakovskiy, M.B., Solov'yeva, E.A., ibid, 159

/—Burch G. E., Abildskow J. A., Cronvicht J. A., Spatial Vectorcardiography. Philadelphia, 1953.—Grishman A., Scherlis L., Spatial Vectorcardiography. Philadelphia, 1952.—Horan L., Burch G. E., Abildskov J. A., Circulation, 1954, v. 10, p. 728.—Lamb L. E., Grosgurin J. R., Duchosal P. W., Cardiologia, 1956, v. 28, p. 65.—Pantridge J. F.,

Abildskov J. A., Burch G. E. a. oth., Circulation, 1950, v. 1, p. 893.—Scherlis L., Grishman A., Am. Heart J., 1951, v. 41, p. 494.—Wenger R., Klinische Vektorkardiographie. Darmstadt, 1956.

END

1658